

Approved by:

_____/_____/_____
Process Engineer_____/_____/_____
Equipment Engineer

1 SCOPE

The purpose of this document is to detail the use of the CHA E-Beam Evaporator. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in loss of privileges.

2 REFERENCE DOCUMENTS

- Material Safety Data Sheet for material being evaporated
- Appropriate Tool Manuals

3 DEFINITIONS

n/a

4 TOOLS AND MATERIALS

4.1 General Description

4.1.1 This evaporator is set up to deposit metal using e-beam evaporation.

4.2 Wafer Holders

4.2.1 Wafer holders for various sized substrates are available.

4.3 Evaporant Sources

4.3.1 Various metal, oxide, and elemental evaporator sources are available. Evaporants in the form of pellets, wire, or fragments may be used. Use of finely powdered evaporant materials is not recommended.

4.4 Crucibles

4.4.1 Crucibles are available in several types such as graphite, alumina, boron nitride and copper. The proper type will depend on the metal that you are depositing. See the "Guide to Thin Film Evaporation" table located near the tool. Some crucibles can be reused (for the same material each time) and may already have materials in them. Crucibles can be ordered from Thermionics Laboratories, part number **A111460-XX** for 2.2 cm³ 3 kW TLI New-style crucibles.

5 SAFETY PRECAUTIONS

5.1 Personal Safety Hazards



5.1.1 In the event of an emergency or any other serious problem depress EPO button (labeled EPO on machine).

5.1.2 The CHA Evaporator employs voltages that are dangerous and may be fatal to personnel. Do not attempt to defeat protective interlock systems.



5.1.3 The CHA Evaporator bell jar is heavy and can pinch fingers or other body parts against the vacuum base plate. Keep fingers and loose objects away from the bell jar sealing surface when lowering the bell jar. **THE UNIT IS AUTOMATIC AND WILL NOT STOP UNTIL CLOSED. KEEP HANDS AND HEAD OUT OF UNIT WHEN CLOSING.**



5.1.4 Various internal components of the CHA Evaporator become very hot during evaporation of metals. These components remain hot for some time after the bell jar is opened, and can burn fingers if touched. Use caution when working with source fixtures after the system has been heated.

5.1.5 Various internal components of the CHA evaporator, which include shields and glass slides, may have sharp edges. Use caution when working with these fixtures to prevent cuts.



5.1.6 Dust and other small metal fragments can be flammable, or irritating to the respiratory tract or eyes. Use caution when working with fixtures or cleaning the chamber to prevent exposure to flakes and dust.

5.2 Hazards to the Tool

5.2.1 Failure to clean up chamber and fixtures after use - Flaking metal deposits on shields and fixtures can generate large quantities of particulates which can contaminate wafers or compromise vacuum performance of the tool.

5.2.2 Damage to bell jar vacuum seal – contact with tools or other objects, or contaminants like flakes or particles, can damage the sealing integrity of the vacuum chamber. Use caution when working with the open bell jar and avoid damaging the rubber seal or the flat base plate mating surfaces.

5.2.3 Deposition on viewports – If possible, sources should be provided with mirrors for viewing rather than having line-of-sight to a viewport. The viewport in the lower chamber should be equipped with a glass slide to prevent accidental coating.

5.2.4 Failure to adjust beam – Make sure beam is centered on the melt to prevent damage to the system.



5.2.5 High-Vapor pressure materials – If materials with a high vapor pressure are deposited, the system will be permanently contaminated. Forbidden materials include Tin, indium, zinc, cadmium, tellurium, and magnesium, among others. You **MUST** verify with SMFL staff that materials to be evaporated are acceptable before using them. Pre-approved materials include Ag, Al, Cu, Au, Fe, Ni, Co, Si, Al₂O₃, SiO₂, MgO, W, Mo, Ti, Cr, and Ge.



5.2.6 Venting while hot – If the system is vented while the evaporator source is hot, it can be seriously damaged. This could range from filament burnout, crucible damage, or warping of the copper evaporator source itself. The system is equipped with a time delay relay that forces a wait of at least 15 minutes before the bell jar is vented, to allow the system time to cool. If you notice that the system does not perform this delay before venting, you must notify a technician immediately.

6 INSTRUCTIONS

6.1 Service Chase Setup

- 6.1.1 Turn on the **E-Beam Nitrogen** on the back of the tool.
- 6.1.2 Make sure the air pressure is about 75psi. (Service chase #2705)

6.2 Start Up

- 6.2.1 Swipe in. After swiping in the water flow on the back of the tool should be about 1.2 gpm as indicated by the red mark.
- 6.2.2 **Panel 6** - Turn on the Mechanical Pump circuit breaker on front of machine.
- 6.2.3 **Panel 1** - Turn on Granville Phillips Ion Gauge Controller by pressing **IG1 button**. If under vacuum then IG1 should already be on. Do not turn on at atmosphere.
- 6.2.4 **Panel 2** - Turn on Inficon XMS-3.
- 6.2.5 **Panel 4** - Auto Tech II knob should be in the Automatic position. (Does not line up exactly)
- 6.2.6 **Panel 5** - Motor Controller switch should be off.
- 6.2.7 **Panel 7** – Thermionics e-gun should be off.
- 6.2.8 **Panel 8** – Thermionics power supply should be off. (Top right of system)

6.3 Loading Wafers

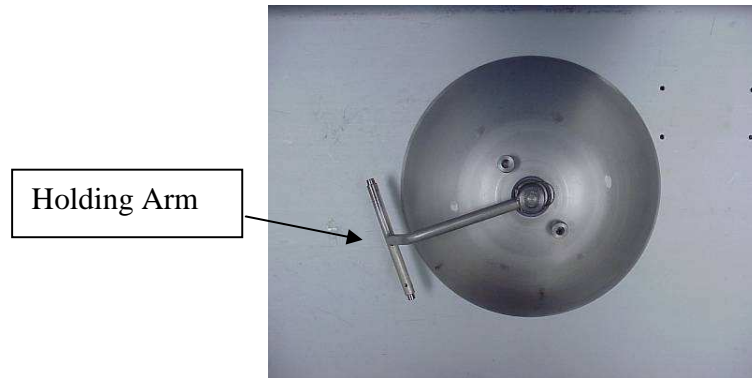
- 6.3.1 **Panel 1** - Turn off ICG1 on Granville Phillips IG controller by pressing **IG1 button**.
- 6.3.2 **Panel 4** - Put **CYCLE/HOIST** switch in the **VENT/RAISE** position. *There is a 15 minute delay before the bell jar will go up.* The reason for the delay is to prevent damage by allowing the e-beam system to cool.
- 6.3.3 Remove Planetary Dome and set on a flat surface. **Do not hold the planetary by the arm only, as it may fall off and damage the planetary and/or your wafers.**



6.3.3.1 Remove retaining clip from back of planetary



6.3.3.2 Remove holding arm by lifting straight up



6.3.3.3 Unscrew backing nut to separate planetary

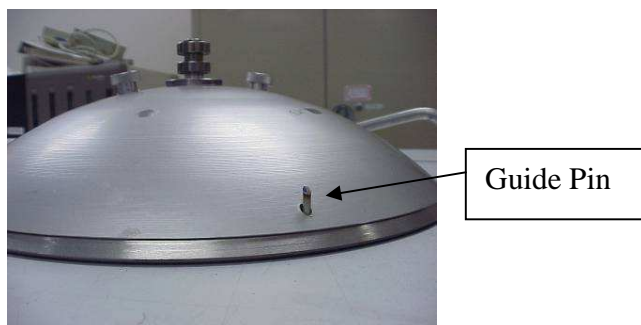


6.3.3.4 Separate planetary



6.3.3.5 Load wafers device side down. Fill open holes with dummy wafers.

6.3.3.6 Reassemble planetary making sure to put guide pin in hole.



6.3.3.7 Screw backing nut onto planetary. **Do not overtighten!**



6.3.3.8 Reinstall holding arm over bearings.



- 6.3.3.9 Re-install retaining clip into slot on holding arm. Pull up on holding arm to insure that clip is engaged.



- 6.3.3.10 Re-install planetary. (use caution- the planetary may fall off the holding arm and break your wafers) Spin unit to ensure proper seating



Spin



- 6.3.4 Install crucibles into pockets.
- 6.3.5 Insert source materials into crucibles. **Do not load the crucible more than $\frac{3}{4}$ full!** If the crucibles are loaded to the top, they can easily jam the rotation and cause severe damage to the evaporator.
- 6.3.6 Use the **Source Selector Knob** on the right hand side of the tool to position the crucible that you will initially use. The selector knob can only be turned in the direction of the arrow marked on it. **Do not force it to turn in the opposite direction!** If the knob requires excessive force to turn, STOP and consult a technician.
- 6.3.7 Wipe down base plate and bell jar gasket with crew wipe and IPA.
- 6.3.8 Insert glass slide into inner skin on lower glass window from inside.
- 6.3.9 Verify that you have a good mirror at the back of the system. You must be able to see the crucible from the front window by using the mirror. Install a new slide at the front of the evaporator crucible carrier to block direct deposition on the front window.

- 6.3.10 **Panel 4** - Push **Cycle/Hoist** switch to lower bell jar and start pump down. **Keep your finger on the switch so that you can stop it if needed.**



DANGER

**KEEP HANDS AND HEAD OUT OF UNIT WHEN CLOSING
UNIT IS AUTOMATIC AND WILL NOT STOP UNTIL CLOSED**

6.4 Programming the Inficon Film Thickness Monitor

- 6.4.1 Press the **On/Stby** button to ignite the green LED.
- 6.4.2 Press **PROG**.
- 6.4.3 Use the arrow keys to select **DENSITY** on the display on the bottom.
- 6.4.4 Use the number keys to set the density of the material desired.
- 6.4.5 Press the down arrow key to select **Z-RATIO**.
- 6.4.6 Use the number keys to set the Z-ratio of the material desired.
- 6.4.7 Press the down arrow key to select **TOOLING FACTOR**.
- 6.4.8 Set the **Tooling Factor** to 82.7% for the standard dome planetaries.
- 6.4.9 Press **PROG** when done.
- 6.4.10 To start a run press Shutter **OPEN**. This will zero the thickness monitor.
- 6.4.11 When complete press Shutter **CLOSE**.
- 6.4.12 Some metal densities and Z-ratios are listed below. Other materials can be found in the "Guide to Materials Evaporation Chart" found near the tool.

METAL	DENSITY	Z-RATIO
Al	2.70	1.08
Cr	7.20	0.305
Au	19.3	0.381
Ni	8.91	0.331
Ag	10.5	0.529
Ta	16.6	0.262

6.5 Evaporation

- 6.5.1 **Panel 5** - Turn motor control for the planetary rotation to low and dial setting to black line. (This is a reference position – if more or less rotation is desired adjust accordingly.)
- 6.5.2 **Panel 5** - Turn knob from **Brake** to **FWD**
- 6.5.3 **Panel 2** – Monitor film thickness on Inficon Film Thickness Monitor. This is in thousands of Å at display (1.000 = 1000Å)
- 6.5.4 **Panel 8** – Turn on Thermionics Power Supply interlock toggle switch at top right of tool.

- 6.5.5 **Panel 3** – Turn on e-gun sweep control. Adjust the sweep controls to the center of their range.
- 6.5.6 **Panel 7** – Make sure the emission current knob is turned all of the way down and that the green ready light is illuminated. Turn emission button **On**. You should hear a loud click when the power supply energizes.



6.5.7 IF YOU HEAR A BUZZING SOUND, PRESS THE OFF SWITCH IMMEDIATELY. Do not try to restart the system, and consult a technician.

- 6.5.8 Increase beam current with the **Emission** knob. The melt should now be illuminated by the beam.
- 6.5.9 **Panel 3** – Adjust the **XY Position** to change the position of the sweep. Adjust the **XY Amplitude** to change the size of the sweep. Make sure the sweep is properly centered in the crucible to prevent damage to the system. If the beam is just a stationary spot it could melt through the bottom of the crucible. Generally the frequency does not need to be adjusted.
- If using more than one crucible, turn the emission knob to zero and press the off button. **Allow the crucible to cool until it no longer glows before advancing to the next source.** The selector knob can only be turned in the direction of the arrow marked on it. **Do not force it to turn in the opposite direction!** If the knob requires excessive force to turn, STOP and consult a technician.

6.6 Unloading Wafers

- 6.6.1 **Panel 7** – Turn down emission knob and then press **Off** button.
- 6.6.2 **Panel 3** – Turn **XY Amplitude** down to zero. Turn off XY sweep control.
- 6.6.3 **Panel 8** - Turn off Thermionics Power Supply.
- 6.6.4 **Wait** until the last crucible used no longer glows red.
- 6.6.5 **Panel 5** - Motor Control switch to off.
- 6.6.6 **Panel 1** - Turn off ICG1 on Granville Phillips IG controller by pressing **IG1** button
- 6.6.7 **Panel 4** - Put **CYCLE/HOIST** switch in the **VENT/RAISE** position. *There is a 15 minute delay before the bell jar will go up.* The reason for the delay is to prevent damage by allowing the e-beam system to cool.
- 6.6.8 Remove Planetary and wafers as previously described.
- 6.6.8 Reinstall planetary. Spin unit to ensure proper seating.
- 6.6.9 Remove crucibles from evaporator.
- 6.6.10 Wipe down base plate and bell jar gasket with crew wipe and IPA
- 6.6.11 Insert a new glass slide into inner skin on the inside of the lower glass window.

6.7 Stand By

6.7.1 **Panel 4** - Press **Cycle/Hoist** button on Auto Tech II to **Start Lower** position.

DANGER

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6.7.2 **Panel 4** - Make sure unit goes into HI VAC on Auto Tech II. HiVac light will be illuminated.

6.7.3 **Panel 6** - Turn **OFF** Rough Pump circuit breaker.

6.7.4 **Panel 2** - Turn off Inficon Film Thickness Monitor by pressing **On/Stby** button.

7 APPROPRIATE USES OF THE TOOL

7.1 To avoid contamination of the system, use only clean wafers and approved evaporation sources.

7.2 Deposition thickness of materials is limited by adhesion strength of the material to the substrate, and tensile or compressive stresses developed in the film. Maximum film thicknesses of 1 micron are typical for most materials. **Consult SMFL staff if you desire to deposit films thicker than 1 micron.**



7.2 If materials with a high vapor pressure are deposited, the system will be permanently contaminated. Forbidden materials include Tin, indium, zinc, cadmium, tellurium, and magnesium, among others. You **MUST** verify with SMFL staff that materials to be evaporated are acceptable before using them. Pre-approved materials include Ag, Al, Cu, Au, Fe, Ni, Co, Si, Al₂O₃, SiO₂, MgO, W, Mo, Ti, Cr, and Ge.



7.3 **Since the system uses an intense electron beam to evaporate material, it creates powerful x-ray radiation. This can cause severe radiation damage to MOS devices.**

R·I·T**Semiconductor & Microsystems****Fabrication Laboratory****Title: CHA E-Beam Evaporator****Revision: C****Rev Date: 01/13/2011****REVISION RECORD**

Summary of Changes	Originator	Rev/Date
Original Issue	Sean O'Brien	A-10/17/2006
Revised after tool damage	Raisanen	B-10/17/2008
Changed location of Nitrogen Valve 6.1.1	Sean O'Brien	C-01/13/2011